the chance of the birth of a male. I operated in accordance with the directions of Prof. Thury, and the success again confirmed the truth of the process which had been communicated to me—a process the application of which is direct and very easy.

Besides my Durham bull, I obtained six other bulls, of a cross-breed between the Durham and Schwitz, which I intended for work: by selecting cows of the same colour and size, I obtained very well-matched pairs of bulls.

My herd consists of forty cows of all ages.

To sum up, I have made in all twenty-nine experiments according to the new process, and all have given the desired product, male or female: I have had no case of non-success. All the experiments were made by myself, without the intervention of any other person.

I can consequently declare that I regard the method of Prof. Thury as real and perfectly certain, hoping that he will soon be able to profit all breeders and agriculturists in general by a discovery which will regenerate the business of cattle-breeding.

(*Signed*) G. Cornaz.

Montet, Feb. 10, 1863.

XI.—*On the Process of Mineral Deposit in the Rhizopods and Sponges, as affording a Distinctive Character.* By G. C. Wallich, M.D., F.L.S., &c.

In a paper published in the Number of the 'Annals' for December last, Professor Max Schultze adduces evidence in support of the opinion that the siliceous spicules found within the chambers of certain Foraminiferous shells do not constitute integral portions of these organisms, but are the products of entozootic sponge-growth,—the evidence in question being based on the strictly Foraminiferous type of the shells in which such spicules occur, on the presence of the latter being only occasional, on their position and distribution when met with, and on the characters of sponge-sarcode as compared with "the organic substance remaining after specimens [of *Polytrema*] preserved in spirits" have been decalcified by subjection to dilute hydrochloric acid.

But whilst this may be regarded as the circumstantial evidence in the case, the opinion advocated by Professor Schultze appears to me to be sustained by proofs of a more direct and generally applicable nature. These I shall now proceed to notice.

According to Dr. Bowerbank*, "in the early stage of their

* "On the Anatomy and Physiology of the Spongiadæ," 'Philosophical Transactions of the Royal Society' for 1858, p. 281 *et seq.*

development the spicula [of Sponges] appear to consist of a double membrane, between which the first layer of silex is secreted; and in this condition they present an internal cavity approaching very nearly to the size of the external diameter." And again: "the deposit of silex is not continuous and homogeneous, but produced in concentric layers, which, it would appear, are, at least for a period, equally secreted by the inner surface of the outer membrane and the outer surface of the inner one."

Now, although all truly *spicular* sponge-growths are formed, as here laid down, by concentric layers of silex secreted from two distinct surfaces, and, in their earliest condition, occasionally "approach very nearly to the size of the external diameter," unless I am much mistaken in my interpretation of the appearances, they are neither "secreted equally" from these two surfaces after the deposit of the first layer evolved by each, nor are they formed within membranous cavities.

In order to render the process intelligible, it is desirable to take as an illustration the simplest type of siliceous spicule, —namely, the common elongate cylinder, without reference to the shape of its extremities, or the closure of its tubule either at one or both ends. But first with regard to the membrane here spoken of by Dr. Bowerbank as occurring among the Spongiadæ, and asserted by Professor Schultze to be present in the Foraminifera*.

In the living or fresh sarcode, whether of the Sponges or Foraminifera, there are no membranous cavities from the surfaces of which mineral deposit takes place†. There are cavities, and these doubtless present a definite outline, but not more definite than that of the vacuole which, in the sarcode of both classes, appears and disappears without leaving the slightest trace behind. It is also true that in spirit-specimens, and under the action of acids, an amount of "hardening" is produced which causes the external layer of sarcode to assume the appearance of membrane. But, as I have endeavoured to show with regard to *Amœba* ‡, we are by no means warranted in taking it for granted that characters, manifest only under the action of a chemical reagent, have necessarily existed prior to its employment; and, in further confirmation of this view, I may state

* See paper above referred to, p. 413, where the following passage occurs: "The organic substance remaining after the treatment of specimens of *Polytrema* preserved in spirits consists of an external membrane and a tenacious brownish-red substance."

† See same paper, p. 418.

‡ "On the Value of the Distinctive Characters in *Amœba*," 'Annals' for August 1863, p. 128.

that the effect of plunging albumen (the substance most closely allied in character to sarcode) momentarily into strong spirit, acid, or even hot water, is to produce on its surface a hardened membranous-looking layer, which, as seen under the microscope, has all the appearance of the ectosarc of *Amœba*. It is a remarkable fact, moreover, that in those specimens of *Amœba* in which the ectosarc presents the nearest approach in aspect to a membrane, under the application of a moderate degree of heat every trace of this vanishes, and the sarcode-mass becomes homogeneous to its extreme margin; whereas, in the encysted condition of *Amœba*, no heat, short of that capable of destroying the tissue altogether, suffices to alter the then strictly membranous character of the cyst*.

One of the most characteristic features of sarcode is its tendency to vacuolation—that is to say, the formation of cavities within its substance, occupied by fluid or solid matter †. The first step in the process of spicular deposit is the formation of such a cavity, subject, of course, to variation in shape and size in different species, but the essential character of which remains the same in every instance. Taking for illustration, then, the simplest type of spicule above referred to, a correspondingly shaped vacuole makes its appearance in the sarcode-mass, but with this singular and constant peculiarity—that its long axis is traversed by a thread of sarcode, or *vacuolar stolon*, as I propose to term it. This stolon is occasionally free at one of its extremities, but never at both. In the adjoining woodcut, a diagrammatic view is given of the order in which the successive layers of silex are deposited in a sponge-spicule, the upper end being closed, the lower open—the sectional view in each case being given immediately below. Fig. 1 represents the vacuolar cavity as seen in section longitudinally, s being the stolon, and *v* the space or cavity produced by endosmotic effusion of fluid containing silex in solution. There are present, therefore, two surfaces of sarcode, namely that of the cavity and that of the stolon. Each of these now secretes a layer of silex, not, however, with an intervening space between, but in the closest apposition. In fig. 2 these two layers are indicated by the horseshoe-shaped spaces numbered 1 and 2 respectively, but which, in all probability, are formed simultaneously.

Now, as each layer becomes immediately consolidated and is

* These cysts may readily be mounted in balsam; but, in the ordinary condition of *Amœba* it is impossible to preserve a vestige of outline when so mounted.

† A vacuole may be defined as *a space in a fluid of one density occupied by fluid or solid matter of another density.*

non-elastic*, no further deposit can possibly be effected from either surface unless by displacement of an equivalent volume of sarcode, whether of the cavity or stolon. The next layer may therefore be formed around the stolon as in layer 4, fig. 4, or by the retrocession of the boundary of the cavity, as in layer 3,

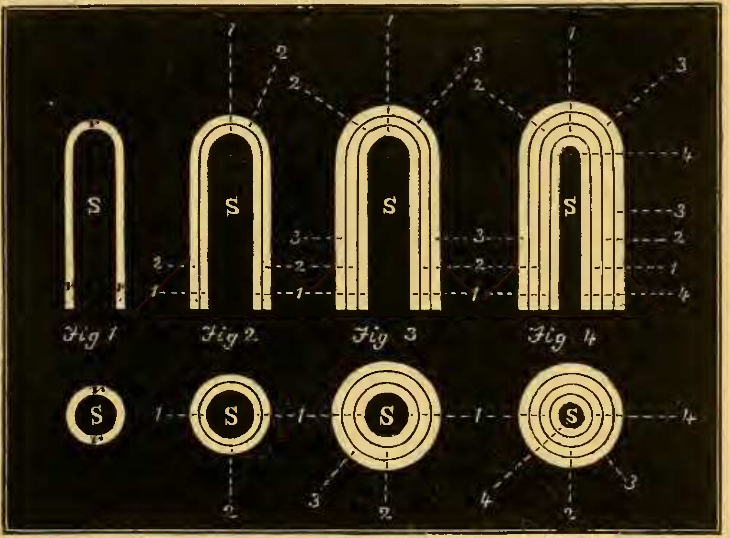


fig. 3. Most frequently the layers are deposited one within the other—this being the reason why the diameter of the first two layers (which generally represent the diameter of the spicule) is "nearly equal to the size of the external diameter," as stated by Dr. Bowerbank. But nevertheless successive layers of silex may continue to be added externally as well as internally. If internally, the stolon gradually diminishes in diameter, and may ultimately be altogether obliterated. Therefore, as a general rule, the greater the diameter of the tubular cavity of a sponge-spicule and the thinner its wall, the younger is the spicule, and *vice versâ* †.

It has been stated that the first two layers secreted are invariably in contact. The proof of this is afforded by the fact that spicules never occur in which there are two distinct hollow cylinders enclosed one within the other, and presenting a free

* It is scarcely necessary, I presume, to state that the siliceous substance of a spicule is resilient, but not expansible.

† When the stolon is continuous with the cavity at each extremity, the layers of silex do not constitute a sealed tube, as shown at the upper portion of the horse-shoe figures, but remain open, as seen at the lower.

intermediate space, such as would necessarily exist were the first two layers not secreted in contact. Hence it follows, that, after the deposit of the two primary layers (by the surface of the stolon and of the vacuolar cavity, as seen in fig. 2), all subsequent layers must be evolved from these surfaces in opposite directions —that is to say, centrifugally as regards the outer series, and centripetally as regards the inner one. And it may be stated that the growth of every sponge-spicule takes place in two opposite directions between its axis and periphery, and that every spicule presents an axial tube (or the remains of such tube), which was originally occupied by the *vacuolar stolon* around which its several layers were deposited.

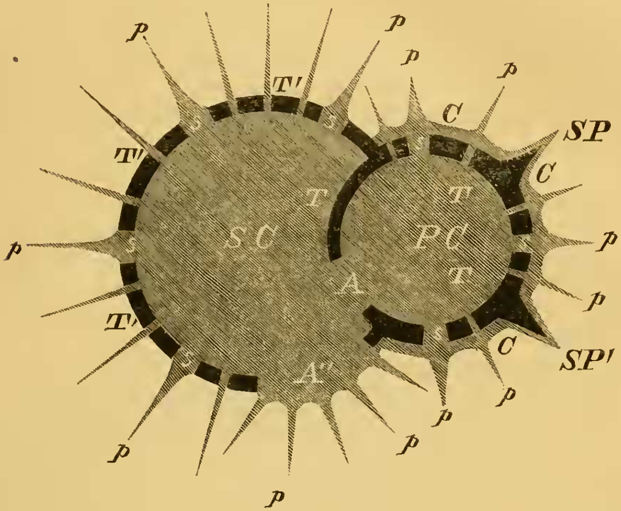
I shall now endeavour to show that, with the exception of one group of organisms which constitute the true connecting link between the Sponges and the Rhizopods, the process of mineral deposit in the latter class of Protozoa takes place so differently from that just described as prevailing in the former, that it furnishes a most important distinctive character between the two classes.

If we leave out of the question the genera *Polytrema, Carpenteria,* and *Dujardinia,* which are still *sub judice,* and restrict the term "spicule" to structure identical in its mode of formation with the spicules of the Sponges, no spicular growth has hitherto been met with amongst the Foraminifera. The point for decision is not whether the spicules found in these genera are true sponge-spicules (for of that fact there is no doubt), but how they came there,—my argument being that, inasmuch as they are undoubtedly true spicular growths, they cannot belong to, or be formed by, Foraminifera, and must consequently be of entozootic origin.

Figure 5 is intended to illustrate the order in which the successive layers of calcareous matter are formed in a shell of the Globigerine type, P C representing the primordial chamber, T T the first layer of shell secreted from the sarcode-surface with which it is in contact; *s, s, s,* pseudopodial stolons traversing the shell through the larger foramina, and terminating at times, but not necessarily always, in pseudopodia; *p, p, p,* pseudopodia taking their rise from an external layer of sarcode (or *chitosarc,* to be described immediately), and, in like manner with the pseudopodial prolongations of the stolons, not always in direct communication with the sarcode-mass within the chambers; and, lastly, A, the aperture of the chamber.

S C represents the second chamber; the letters T′ T′ the first layer of shell, as in the primordial chamber; s, s, the stolons, with the large foramina for their exit; *p, p, p,* pseudopodia, in this case springing directly from the sarcode-mass of the chamber—A″ being the principal aperture, through which the sarcode-mass is seen to bulge outwards.

Fig. 5.



The difference between these two chambers deserves special attention. As already stated, the first layer of shell is deposited from the immediate surface of the sarcode-mass within, being only interrupted at the main aperture and those points through which the stolons and pseudopodia make their escape. In the normal condition of the organism, no further deposit takes place within. Every subsequent addition to the thickness of the shell-wall is made from without, and is brought about by a special layer of sarcode which spreads over the entire external surface from the stolons*, and thus seems to secrete the shell-substance by its gradual retrocession outwards, as in the case of the wall of the cavity in which the sponge-spicule is formed. This outer layer of sarcode may very readily be seen in mature *Globigerinæ,* and it is probably present in all Foraminifera, although visible with difficulty in some, too subtle to be appreciable in others, and perhaps taking its origin, in the imperforate genera, by a distinct reflexion of the sarcode-substance through the main

* These stolons, unlike those which take part in the secretion of silex in the case of the sponge-spicule, seem designed actually to *prevent* the deposit of calcareous matter wherever they occur; since otherwise no apertures would remain for communication between the internal sarcode of the chambers and the medium in which the organism lives.

aperture of the last-formed chamber, after the fashion of *Gromia* *.

Of the highly important office performed by this outer layer, there appears to be no room for doubt. Owing to this importance, and the misconception that would inevitably arise were it to be regarded as made up of ectosarc alone, I have thought it necessary to distinguish it from the rest of the soft mass by the name of *chitosarc* (χιτὼν, a coat). But it must be expressly understood that this layer is not distinct in constitution from the rest of the sarcode, but formed out of it, and (as in the case of the naked Rhizopods) continually intermingling with the internal portion by amœbasis. It is through the agency of the *internal* surface of this layer or chitosarc that the increase in the thickness and strength of the shell is effected, the various complicated canal-systems formed, and all secondary deposits and the entire series of surface-markings of the Foraminifera produced†.

This layer would seem to be present in all the testaceous genera of Rhizopods. In *Gromia* it has long been recognized, and supposed to be altogether derived from a reflexion of the sarcode-mass issuing at the mouth of the test. In the Polycystina, as in the Foraminifera, it undoubtedly produces all the beautiful sculpturings for which these organisms are so celebrated. The growth of the siliceous framework of the Acanthometrina and Dictyochidæ is almost wholly dependent on its presence; whereas in the highest order of Rhizopods, namely the Proteina, it is extremely probable that it occurs also in all the testaceous genera, although, from the greater differentiation of the sarcode-substance generally, it is more delicate and less easily traceable. In this order I have not seen it; but there seems reason to suspect that in *Euglypha* and indeed all the Lagynidæ, and also in the testaceous Amœbans (as in *Difflugia* and *Arcella*), it is not only reflected from the main orifice, but escapes partly through the minute pore or pores which are distinctly visible at the apex of the test in *Euglypha, Cadium, Protocystis* (Wall.), and *Difflugia*. In the latter genus the pore is at times produced into a hollow cylindrical tube of some length, as shown in my paper on *Amœba*,

* For reasons which will be given in a later portion of this paper, I am inclined to believe that the test of *Gromia* may not be strictly imperforate.

† The presence of an outer investing film of sarcode in certain Foraminifera appears to have been recognized by Dr. Carpenter and Prof. Schultze. In the 'Introduction to the Study of the Foraminifera' (p. 128), the former author accounts for the exceptional structure of *Dactylopora* by ascribing its formation to this outer film, and cites *Gromia* as an example in which it is reflected back over the entire test, from the sarcode-body protruded through the main aperture.

&c., in the Number of the 'Annals' for June last (Pl. X. fig. 13) and in those forms of *Arcella* in which a number of spine-like processes are formed, and the original chitinous test becomes covered with sandy particles, it is probably through apertures in these that the sarcode escapes.

Lastly, it is a most interesting fact, that, if we turn to the Protophytes, as, for example, the Diatoms and Desmidians, a layer of protoplasm, as is well known, envelopes the harder portions exteriorly. This layer is homologous with the chitosarc of the Rhizopods.

Now one of the strongest corroborations of the view here advanced is to be found in the fact that in an abnormal condition of the oldest Globigerine shells, in which the larger foramina become almost wholly obliterated by calcareous deposit (and it would appear that elective affinity exercises greater power than the inherent secretory faculty of the sarcode), a secondary free layer of shell-substance becomes deposited *within* the primary layer; and from this the delicate calcareous spines present in some of the heaviest of the free-floating *surface* Globigerinæ of tropical seas seem to be projected. At first sight these spines look like pseudopodia; they are undoubtedly calcareous, however, and, as before stated, never tubular.

In the diagram a second layer is represented as having been already added on the external surface of the primary chamber, P C,—this layer extending, however, only over the external area of the primordial chamber, and not over that portion of it which is covered by the second chamber, S C. The latter is represented as seen prior to the deposition of this outer or secondary layer—the spreading out of the stolons, so as to form the chitosarc, having yet to take place before any external addition to the shell can be brought about. Thus it has been shown that the deposit of mineral matter, of which the Foraminiferous shell is composed, takes place only in one direction at a time, and not within a cavity, but either upon or within a surface of sarcode.

The same remark applies to the spinous projections which are occasionally present. These may be traversed by a canal-system, but they never exhibit a tubule originally occupied by a stolon from which they have been partly secreted. On the contrary, they are built up of consecutive additions of calcareous matter, laid on, as it were, at right angles to their axes, and extending in one direction only, that is to say, from the axis of the chamber outwards; whilst the secreting surface constitutes a progressive mould into which the mineral matter is poured out, the base of the secreting cavity being, at the commencement of the operation, closed by the calcareous area upon which the spinous process is projected. Here it is evident that the internal sarcode of the chamber on which the spinous processes occur has no direct share in their production, from the circumstance of there being no aperture or pit at the interior point of the calcareous chamber which corresponds to the base of the process exteriorly. It may be stated, therefore, that the process of spine-formation in the Foraminifera is brought about by the secretion of calcareous matter upon an already existing calcareous surface, each successive layer being received into the mould progressively made for it by the outward extension of its investing chitosarc. Fig. 5 diagrammatically represents the process, SP being the first and SP′ the second stage of spine-formation referred to.

On these grounds, then, coupled with the fact that no Foraminifera secrete silex, although several genera build up their shells by the addition of siliceous and other mineral particles derived from extraneous sources, I base my opinion that the spicules met with occasionally in *Polytrema, Carpenteria,* and *Dujardinia* * do not constitute integral portions of these organisms, but have their origin in entozootic growth; and further, that the process of mineral deposit in the Sponges, as compared with that prevalent in the Foraminifera, is absolutely incompatible with the formation of true spicular growth.

In the Polycystina the plan of mineral deposit is in every essential respect identical with that observable in the Foraminifera. That is to say, the siliceous portions (which do not constitute a shell, but ought to be regarded as an internal skeleton or framework) are formed by the addition of siliceous matter at right angles to the principal line of growth, and in one direction only. They are never formed around stolons, and consequently are not tubular—the finer threads of silex being projected from point to point of the reticulations, much after the same fashion that the threads of melted glass are fashioned by the glass-worker into miniature baskets, &c.,—the spinous processes so largely developed in this family forming no exception to the rule, and it being only in the earliest rudiment of the siliceous structure that the silex is deposited in the shape of an extremely minute composite but solid spicule within the sarcoblast. This identity in the plan of deposit in the Foraminifera and Polycystina, notwithstanding the difference in the mineral material and the character of the hard parts, therefore yields a reason in addition to those derivable from the organization of the soft parts for the view advanced by me regarding the ordinal unity of these two families.

* On similar grounds I consider the marginal cord in *Operculina* to be an ordinary secondary growth, in no wise analogous to spicular development.

In the Acanthometrina which belong to another order, namely, the Protodermata, the plan of siliceous deposit is nevertheless essentially the same—the elongated spines (acanthostypes) never being tubular, as erroneously asserted by Professor Müller. The appearance of tubularity in these organisms, as in the Polycystina, is an optical illusion engendered by the longitudinal ribs of which the acanthostypes may be said to be made up*.

In the Thalassicollidæ, which, together with the Dictyochidæ, are placed by me in the same order as the Acanthometrina, the plan of deposit is for the first time modified, but only to the extent of taking place in two directions from the axis of each spicule. In other words, the spicule is deposited within the sarcode entirely, but not in previously existing cavities or around stolons. Hence the silex is secreted only from within outwards.

Lastly we arrive at the Dictyochidæ, a group I have found it necessary to set apart as a distinct family, owing to the fact of their presenting the solitary example of true tubular formation amongst the whole of the Rhizopods. In the organization of their soft parts they are closely allied to the Acanthometrina and Thalassicollidæ; whilst the tubularity of their siliceous framework, and its formation of *two* separate isometrical portions, at once stamp this family as the true connecting link between the Rhizopods and Sponges. It is a singular fact that upwards of twenty varieties of these very common organisms have been described as distinct species on characters of no higher import than the number of spines or angles presented by the siliceous framework; and that some have actually been described and figured as seen in a living condition *with half of the internal skeleton deficient!*

It only remains for me to add that in other genera of the Foraminifera than those referred to by Professor Schultze (as, for instance, in *Globigerina*), and likewise in some of the Polycystina (*Haliomma*), specimens are not unfrequent in which the chambers are more or less choked up with entozootic sponge-growth; whilst the chambers of *Globigerina* are at times filled with effete frustules of a free-floating pelagic *surface* Diatom, namely, *Chætoceros*.

Hence, assuming the order of deposit of the mineral matter of all these structures to be constant amongst the members of the same family, the facts now advanced furnish the fullest

* In the 'Annals' for October 1863, Mr. Carter describes, under the name of *Acanthocystis turfacea*, an organism recently found by him in Devonshire, which he refers to the order Echinocystidia (Echinocystida?) of MM. Claparède and Lachmann. The spines in this form are said to be hollow; but, for reasons above given, this would at once remove it from *Acanthometra*, and indicate, in this respect, its close affinity to *Acineta*.

confirmation of the accuracy of Professor Schultze's view; and we must henceforth regard all siliceous spicules exhibiting tubular cavities as distinct in their origin from the organisms within whose chambers they occur, unless every portion of the wall or framework of such chambers is similarly constituted.

Kensington, December 18, 1863.

XII.—*On undescribed British Hydrozoa, Actinozoa, and Polyzoa.* By the Rev. Alfred Merle Norman, M.A.

[Plates IX., X., XI.]

Although the animals formerly associated in the class Zoophyta have long since been physiologically parted asunder, it is often practically convenient to unite them, or rather, perhaps I should say, to arrange them side by side, in our collecting, our cabinets, and our papers. I trust therefore that this practical convenience may be deemed a sufficient excuse for here bringing together descriptions of animals belonging to totally different classes.

I must return my sincere thanks for the assistance that I have received from my ever-kind friend, Mr. Alder. Any value that this short paper may have will be due to his accurate drawings which illustrate the species.

Class HYDROZOA.

Fam. Corynidæ.

Genus Tubiclava (Allman).

Tubiclava Cornucopiæ, n. sp. Pl. IX. figs. 4 & 5.

T. reticulo tubulorum conchis viventibus adherentium basali; hydrothecis ab hoc reticulo assurgentibus cornucopiis forma similibus, supra quam infra paulo latioribus, suberectis, vix curvatis, subdiaphanis, incrementi lineis plus vel minus circumcinctis; polypis elongato-claviformibus, tentaculis filiformibus, discretis, et in capite et in stipite sparsis; gonophoris mori fructus formam referentibus, gonoblastidiis brevissimis, tubulis repentibus adjunctis, affixis.
Pollicis quadrantem vix attingit. Mare Zetlandicum habitat.

A number of little trumpet-shaped tubes arise from a creeping base, which is attached to the shells of living Mollusca. These slightly curved tubular hydrothecæ are a fifth of an inch or a little more in height, narrowest at the bottom, and from thence of gradually increased diameter towards their distal extremity. Here and there encircling slightly elevated lines on the hydrotheca mark the successive stages of the animal's growth. The polypites are furnished with greatly elongated club-shaped heads, over the whole of which, as well as upon the upper portion of